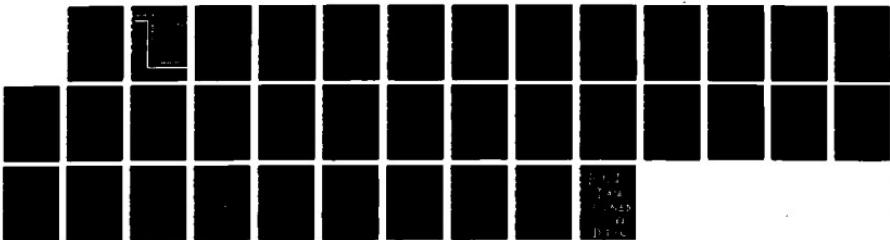
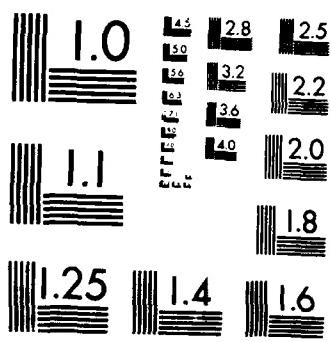


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TRAINING DECISIONS SYSTEM:  
DEVELOPMENT OF THE FIELD UTILIZATION SUBSYSTEM

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19. ABSTRACT (Continue on reverse if necessary and identify by block number) This document summarizes the research undertaken to develop the Field Utilization Subsystem (FUS), one of four basic subsystems of the prototype Training Decisions System (TDS). The TDS is a computer-assisted decision system that will be developed to aid in planning the what, where, and when of training for Air Force career ladders. The FUS addresses the "where and when" to train in a career ladder. This three-component subsystem has first the task of describing the current Utilization and Training (U&T) pattern for an Air Force specialty (AFS) and second, provides a means for collecting alternatives to the current U&T pattern. The third component is responsible for determining which U&T pattern alternatives are preferred by various Air Force manpower, personnel, and training managers. The U&T patterns show job structures and personnel flow. Job analysis, or job-typing, using Comprehensive Occupational Data Analysis Programs (CODAP) routines and current Air Force job-typing methodologies helped to establish job structures for the patterns. Dynamic cross-KPATHing analysis, as a starting point, and Subject-Matter Expert (SME) judgments were instrumental in identifying training states and transition probabilities in relation to the job in the current U&T patterns. SME judgments were the primary source for alternative U&T pattern generation. In turn, the alternative U&T patterns in narrative (Continued)			
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and diagram form were the source for determining managers' preferences through the administration of surveys. The research produced a coherent and internally consistent model. Key areas:

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## SUMMARY

The Air Force enlisted training system is an extensive operation. The thousands of people who enter the Air Force each year undergo some type of training at various points in their careers. This training is provided in different settings such as resident technical training courses, Field Training Detachments (FTDs), on-the-job training (OJT), correspondence courses, and others. Many important decisions which influence training outcomes must be made by the various Air Force agencies responsible for enlisted personnel utilization and training. Currently, coordination does not take place among the various agencies responsible for determining what, when, and where to train. The Training Decisions System (TDS) will be a four-subsystem computerized training decisions aid. The Task Characteristics Subsystem (TCS) will help decision-makers to determine where and how long tasks should be trained, while the Field Utilization Subsystem (FUS) will help determine patterns of personnel utilization. The Resource/Cost Subsystem (RCS) will provide estimates of training cost and capacity for personnel utilization and training alternatives. Finally, integrating these issues to determine optimal training solutions will be performed by the Integration and Optimization Subsystem (IOS).

The FUS has three major components. The Current Utilization and Training (U&T) Pattern Component describes the currently existing U&T pattern of an Air Force specialty (AFS). An Alternative U&T Pattern Component provides logical possible changes to the current pattern. Finally, the Management Preferences Component allows comparison of preference data across managerial groups. The task of constructing current U&T patterns first required identifying jobs in terms of the Task Training Modules (TTMs) from the TCS. Air Force job-typing procedures were used for this task. The effort to construct the job flows involved dynamic Cross-KPATH Analysis to determine where respondents were during two survey administrations (i.e., time 1-time 2). Other procedures were tested, among them the use of Subject-Matter Experts (SMEs) to draw U&T patterns and the use of a U&T History Survey. The current U&T patterns were the foundation for alternative U&T patterns developed from functional and training manager inputs. Finally, the alternative U&T patterns, contained in survey booklets, were presented to managers as a means for collecting managers' preference data. The procedures developed for the FUS provided usable U&T patterns for all four AFSs involved in the study.



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## PREFACE

The Field Utilization Subsystem (FUS) is one component of the Training Decisions System (TDS) research and development (R&D) effort. The TDS is a multi-year, multimillion dollar R&D effort consisting of four research components and is sponsored by HQ USAF/DPPT and HQ ATC/XPC. This effort is being accomplished under Project 7734 and is designed to provide a more integrated approach to training problems.

A project of this magnitude requires the cooperation and dedication of many people. In this respect we acknowledge the professional contributions made by Mr. Wayne Archer of the Manpower and Personnel Division, Air Force Human Resources Laboratory. Special thanks go to all the Major Commands for their assistance in making available the Subject-Matter Experts who were instrumental in providing the data for the FUS and to the training and functional managers of the AFSs involved in this study.

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## 1.0 INTRODUCTION

The Field Utilization Subsystem (FUS) is one of four basic subsystems of the prototype Training Decisions System (TDS), which is being developed under contract for the Air Force Human Resources Laboratory (AFHRL). It has three main purposes within the TDS:

1. It describes the current Utilization and Training (U&T) pattern for a specific Air Force specialty (AFS). U&T pattern development involves identifying the present structure of work and training in a career field, determining the manner of personnel flow between jobs, and describing relationships between training and the work performed.
2. It provides a means for developing alternatives to the current U&T pattern that might improve some aspect of work or training in the career field. Examples include ideas that might result in lowered training costs, enhanced readiness, or elimination from the career field of those tasks which would be more appropriately performed by members of another career field.
3. It provides methods to assist Air Force managers of various sorts (e.g., functional managers, training managers, personnel managers) in rating the current pattern and alternatives according to preference, compiles preference scores from the ratings, and examines the reasons why some alternatives are preferred over others by the different sorts of managers.

This paper documents the research and development (R&D) on the procedures, software, and instrumentation of the FUS to support these objectives.

### 1.1 Other TDS Subsystems

In addition to its intrinsic purposes of describing and comparing U&T patterns, the FUS must also interface with other TDS subsystems. First, FUS jobs must be described and manipulated in terms of Task Training Modules (TTMs) produced by the Task Characteristics Subsystem (TCS). TTMs are groups of tasks which can and should be trained together. Perrin, Knight, Mitchell, Vaughan, and Yadrick (1987) described the concept of TTMs, including their justification, development, validation, and other uses within the TDS.

The FUS must also present information about job structures and personnel flow in terms suitable for use by the Resource/Cost Subsystem (RCS). Briefly, the RCS (Rueter, 1986) determines the training resources required to support the current and suggested alternative U&T patterns, and the costs associated with providing those resources. This allows U&T patterns to be compared on the basis of training cost to the Air Force.

Finally, the information supplied by the FUS must be fed to the

Integration/Optimization Subsystem (IOS). The IOS is the "meeting point" when products must be passed from one subsystem to another. The IOS contains modeling/optimization routines that will allow "what if" projections; it can optimize variables in one subsystem with respect to constraints imposed by variables in the same or another subsystem. The IOS will also provide user interface software, for example, to control report selection options.

### 1.2 The TDS and Air Force Training Decision-Making

Air Force enlisted personnel require different sorts of training at many points in their careers, and the Air Force operates a large-scale training establishment to meet their needs (Mitchell, Sturdevant, Vaughan, & Rueter, 1986). Various factors impact the management of this training system. For example, training is provided in several settings, including basic and advanced resident training schools, Field Training Detachments (FTDs), Career Development Courses (CDCs), on-the-job training (OJT), Mobile Training Teams (MTTs), and others. Moreover, management of these settings is the responsibility of more than one authority, creating problems of coordination. Various managers in Air Training Command (ATC) are directly responsible for resident training and CDCs, whereas OJT is a responsibility of the Air Force Manpower and Personnel Center (AFMPC), major commands, and first-line supervisors.

An important training management issue concerns training allocation; that is, who should be trained on which job requirements in what setting. Decisions regarding this issue depend, in turn, upon assumptions about how airmen will be used; i.e., the structure of the jobs they will have to perform. For this reason, other managers besides those chiefly interested in training must be concerned with training issues and must be involved in making important decisions regarding training. Finally, the costs, resource requirements, and resource capacities available in the various settings should properly be weighed when training decisions are made. Although data of this sort are available for some training settings, few objective data are available concerning costs and capacities for other settings, such as OJT.

At present, some coordination does take place among the various managers whose decisions determine or influence the training system. For example, Specialty Training Standards (STSs) serve as contracts between ATC and other Air Force commands, specifying what training will be provided in formal resident courses and what will be provided elsewhere. Also, U&T Workshops have become regular events. These allow managers concerned with manpower and personnel utilization to meet those concerned with training in order to make coordinated decisions. The Air Force's Occupational Survey (OS) program supports the process by providing managers with some relevant data. In addition, Training Planning Team (TPT) meetings take a long-term view of the specialty, especially with regard to new weapon system training, while RIVET-WORKFORCE meetings address the functionally oriented initiative to consolidate personnel utilization and training (Mitchell et al., 1986).

Despite these coordination activities, training decisions made by managers are often informal and less than optimal. To a large extent,

this is due to the fact that much of the information required for better decisions remains unavailable, much of the available information is not suitably aggregated, and data from various sources are not easily compared.

The TDS will serve as an aid for improved decision-making in the areas of manpower and personnel utilization and training, partly by providing the required data to managers. Some of this information is new, but much old information has been collected into a single data base for the first time and aggregated in new and useful ways. The TDS also provides decision-makers with additional capabilities, such as models for projecting the future effects of various constraints and assumptions, and the future consequences of their decisions. Managers will be better able to assess the broad range of effects resulting from various policy decisions and to make manpower, personnel, and training decisions which best meet multiple policy objectives.

In general, the TDS will accomplish these objectives by making available and expressing relationships among a number of training, manpower, and personnel utilization variables. The following types of variables are explicitly represented within the TDS:

1. Task Characteristics
2. Task Allocations to Training Settings
3. Managers' Preferences for Task Allocations to Training Settings
4. Times Required to Train Tasks in Various Setting Allocations
5. Utilization and Training Patterns
  - Jobs and Associated Tasks
  - Training States (e.g., FIDs, CDCs, Resident Courses)
  - Transition Probabilities Between Jobs and Training States
  - Numbers of Airmen in Training and Job States
6. Managers' Preferences for U&T Patterns
7. Training Costs
8. Training Resource Requirements
9. Training Capacities

### 1.3 FUS Components

The FUS has three major components. The Current U&T Pattern Component provides a description of the pattern which currently exists in an AFS. The Alternative U&T Pattern Component produces descriptions of alternative U&T patterns which are or may be of interest to managers concerned with the AFS. Finally, the Management Preferences Component gathers and arranges data concerning managers' preferences between the present and various alternative patterns developed in the first two components.

#### 1.3.1 Current U&T Pattern Component

In general, a U&T pattern is a dynamic model reflecting how airmen move or might move through jobs and training states in a specialty. Thus, the first characteristic of a U&T pattern is the set of jobs in the pattern. For present purposes, a job is defined as a collection of positions which are similar in task content and which differ from other jobs; a position is the work done by an individual. Job content, however, is described in terms of the TIMs (Task Training Modules) produced by the

TCS. Appropriate association indices have been developed to describe the relationship between a given job and each individual TIM.

The second major characteristic is the set of training states associated with an AFS. A training state is a particular example of a training setting; for example, a particular FTD. Thus, a particular stream of successive job and training states will represent an AFS-specific typical career path from Basic Military Training (BMT), through the first resident technical school (in most cases), then through the first job assignment and additional training required for that job. Finally, subsequent jobs and associated training are represented until separation from the Air Force occurs. Because U&T patterns must be easily presented to and understood by managers, some simplifying principles and assumptions are required. For example, atypical positions may be grouped ("other jobs") or deleted from the final models to avoid the "cognitive overload" that could arise from consideration of overelaborated models.

Thus, the major product of this component is a representation of the current U&T pattern in an AFS. The representation is developed in sufficient detail to allow accurate functioning of the integrated TDS. Initial inputs include data from the most recent OS for the AFS, the results of the subsequent re-analysis and new analyses performed on those data, information concerning training courses, personnel and manpower data, and information gathered from subject-matter experts (SMEs) and job incumbents.

#### 1.3.2 Alternative U&T Pattern Component

Alternative U&T patterns are described within the same framework as the current U&T pattern, to allow maximum comparability in determining managers' preferences. Alternative patterns include logical possible changes to the current pattern; for example, the provision of job training in settings other than those now used. Such changes might reflect a theoretically determined optimization of resource usage, such as a minimization of training costs. Or, such changes can reflect Air Force management plans, expectations, and recommendations about the future structure of an AFS. For purposes of the FUS, these alternatives will be both described verbally and expressed in the framework of a mathematical model. Any actual optimization operations would make use of data from other subsystems as well, and therefore be carried out by the IOS.

#### 1.3.3 Management Preferences Component

In this component, the various U&T patterns are presented to key managers concerned with the specialty. Such managers are given the opportunity to express their preferences for the patterns, based primarily upon concerns of preparing AFS incumbents to efficiently perform the work required by the Air Force. Ideally, other considerations such as costs would not affect their preferences; such concerns are the domain of the RCS. In practice, however, it may not be possible to restrict the criteria on which preferences are based. In any event, one purpose of this component is to allow comparison of preference data across managerial groups. For example, the preferences of functional managers might be very different from those of personnel or training managers. Identification and resolution of such differences is a primary purpose of U&T Workshops and TPT meetings.

## 2.0 RESEARCH AND DEVELOPMENT OF THE FIELD UTILIZATION SUBSYSTEM

### 2.1 The Current Utilization and Training Pattern Component

#### 2.1.1 Air Force Job Typing

The Air Force method of job analysis, or job typing, has evolved and improved over a period of some 25 years or more (Christal, 1974). Perhaps the best introduction to this subject for an interested reader is Archer (1966), which will acquaint one with the basic rationale and procedures; although many more supporting materials are available today than when it was written, the techniques of operational job typing have not changed over the years. Fundamentally different alternatives have begun to appear (see, for example, Mitchell & Phalen, 1985), but these are still in the research stage.

Basically, an AFS is conceptually comprised of a set of tasks which describe the work done by specialty members. A group of very knowledgeable senior members of the specialty are periodically charged with reviewing and revising a task list produced by the Occupational Measurement Center (OMC). (There are typically several hundred tasks in the final task list.) This task list is included in an OS, and distributed by the Occupational Survey Branch of OMC. A large, often full census sample of appropriate airmen receives the survey, which they complete by checking in the survey booklet each task they perform in their present assignment, and rating on a nine-point scale the amount of job time they spend on the task. This time rating is standardized or converted into an index resembling a percent. Analysis of the similarity of work done by any two or more individuals can then proceed according to either the sheer number of tasks they perform in common or according to the "percent" of work time they spend on tasks they perform in common. Similarity indices are computed by a hierarchical clustering algorithm due initially to Ward (1963). The algorithm begins by clustering the most similar people (or positions), then iteratively draws additional people into the various groups and forms new groups as necessary. In effect, the initial groups grow in size and merge with one another until a final cluster comprises the entire sample. The overall similarity of group members to one another decreases gradually as the groups grow in size. A human analyst must examine a hierarchical clustering diagram and decide just which clusters' members are similar enough to each other and different enough from those of neighboring clusters to be considered identifiable jobs.

There are some potential pitfalls inherent in this process. First, it is highly subjective; although the clusters and similarity indices will always be the same (other things, such as starter group size, being equal), it is not impossible for two different analysts to identify somewhat different groups as jobs. Second, the algorithm used often fails to place 5%-20% of AFS members in any cluster until the within-group similarity is so low that no experienced analyst would consider it a job. This is not intended as criticism. Most people familiar with the

job-typing process agree that it is valuable, although some improvements in the technology are needed. Several new methods are being developed and evaluated (see Mitchell & Phalen, 1985; Phalen, Mitchell, & Staley, 1987; Phalen, Staley, & Mitchell, 1987).

#### 2.1.2 First-term Versus Career Job Types

We began the job-typing effort by exploring the issue of overlap between jobs held by first-term and career airmen. It was considered possible that they perform fairly distinct technical jobs in some specialties, with little overlap between first-term and career members' tasks or the skills and knowledge required for those tasks. There are obvious implications for the FUS if this is so for any of the prototype TDS specialties.

The typical job-typing exercise begins by creating a file that contains all the data from the OS. Since each TDS specialty had been the subject of a recent study by OMC, a file for each already existed, stored on archived tapes. The Comprehensive Occupational Data Analysis Programs (CODAP) system, which is available on the AFHRL's Sperry-Univac computer, contains various utility programs which can retrieve files from archives and prepare them for further analysis.

Once these files are ready, additional CODAP routines automate the job-typing process up to the point of producing a tree-like diagram of the clustering results. Some of the programs produce additional files containing the results of their calculations in a form suitable for input to further programs. The analyst has both the products from these programs and additional optional programs to work with in determining the job types. The present effort followed this basic procedure, except that for AFSs 811XX (Security Police) and 328X4 (Avionic Inertial and Radar Guidance Systems) the process was repeated on separate files. One file in each specialty contained data for first-term personnel, who were defined as those with up to 48 months Total Active Federal Military Service (TAFMS). The other file contained data for career personnel, who had TAFMS of greater than 48 months.

#### 2.1.3 Results for AFSs 328X4 and 811XX

The results of job typing were documented in informal communications throughout the effort, and finally in detail as a hard-copy contract data deliverable. The basic result is that the job types identified by the OMC analyst and described in the Occupational Survey Report (OSR) for each specialty were adopted with few changes for use in the prototype TDS. Although there are some distinctly first-term or career job types, the majority of jobs are comprised of a mixture of the two. Separate clusterings were not found to produce substantially different sets of jobs. In a few cases new jobs could have been created, but there was no reason to believe that this approach would offer any advantages over the OMC jobs for the purposes of the TDS.

2.1.3.1 AFS 328X4. In AFS 328X4, the separation of first-term and career personnel did not alter the basic composition of the job types. There were a few jobs that were comprised completely or almost completely of either first-term or career personnel, so some groups were evident in one clustering diagram and not the other. The career-only jobs were all senior supervisory and management positions. The first-term-only

jobs tended to be small groups, the members of which were very new to the career field and performed mainly very simple maintenance functions. For the most part, jobs consisted of fairly equal numbers of career and first-term personnel who reported doing very similar sorts of work. None of these findings constituted a surprise, however; this sort of information emerges from a routine job analysis which does not split the specialty. The split, however, did cause superficial disruption of the clustering patterns, with lingering separation of some people who came together during early iterations of the whole-sample clustering. But the reasons for separation were not substantial because the differences that kept them apart were merely subtle variations in performance of the same basic groups of tasks or the order in which they linked early in the hierarchical process.

The analysis of AFS 328X4 revealed a gradual career progression from the very simple maintenance tasks assigned to some very new personnel, through a long intermediate career that involves primarily challenging technical work with gradually increasing supervisory and management opportunities, culminating in purely supervisory/management activities for very senior personnel. Even so, most members (including quite senior members) of the specialty remain involved in technical work.

2.1.3.2 AFS 811XX. A subcontractor (Research Triangle Institute) performed the preliminary CODAP analysis of the 811XX specialty. The findings closely paralleled those of the 1984 OSR. For example, some 35 job types were identified, whereas the OSR identified 34. A more detailed analysis by McDonnell Douglas personnel resulted in the identification of 41 first-term jobs. Despite apparent disparities, close examination showed that some of these job types were equivalent, and that only minor differences in task ordering characterized the groups. Equivalent jobs were therefore assigned the same job title in the final analysis, and the OSR jobs were used with only minor changes. As with AFS 328X4, the career field can be described overall as involving a set of very simple first jobs, a set of purely supervisory/managerial jobs performed by very senior personnel, and a large set of intermediate jobs within which gradual increases in supervisory opportunities are apparent. This simplifies the picture somewhat; additional complications result from the fact that AFS 811XX actually encompasses three different career fields. This results, for example, in restrictions on movement between 811X2A (Military Working Dog Handlers) and the rest of 811X2 (Law Enforcement). Some 811X2A members believe that their supervisory opportunities are constrained in comparison to those of 811X2 members. The impact of these issues on the prototype TDS, however, appears minimal.

#### 2.1.4 AFSS 305X4 (Electronic Computer and Switching Systems) and 423X1 (Aircraft Environmental Systems).

The job-typing method employed for AFSS 305X4 and 423X1 was somewhat different than that used for the other specialties. One difference is of little interest for present purposes, but should be mentioned in passing.

These specialties were analyzed using the new version of CODAP, written in ASCII FORTRAN, which is now being tested by AFHRL and OMC. This is an updated and expanded version of the older Fielddata version of CODAP (Phalen, Weissmuller, & Staley, 1985). The purpose of the new system is the same, but in many respects it is more streamlined and easier

to use than the older version. There are also new program names, often for programs which combine more than one old version program into a single step. There are also additional capabilities, but, by the same token, the older version was also expanding constantly. In any event, the sequence of job-typing events was logically the same under either version. There were some problems along the way, usually involving "bugs" found in new, relatively untested programs, or else involving revisions to programs and documentation in the middle of some particular effort. Working with two systems presented certain problems, although the new system represents a considerable improvement over the old in many respects.

The other difference is more substantial. Whereas the analysis for 811XX and 328X4 consisted of producing and working with separate diagrams for first-term and career airmen, the lack of interesting differences between the OMC job types and those identified in the split samples suggested that a simpler approach was probably acceptable.

The two additional AFSs were analyzed by producing a single clustering solution and diagram for the entire specialty, then using CODAP programs to split each OMC job type into first-term and career groups. Additional CODAP programs produced duty- and task-level job descriptions of each split job. As before, only very slight differences were found between first-term and career airmen in any given job occupied by both. The differences were never large enough to indicate that the two should be considered distinct job types.

Subsequent refinement of 423X1 jobs resulted in a large OMC job type being split into three pieces, of which two were small job types and the third was nearly as large as the original. All the jobs in the 305X4 OSR were adopted with no changes. This was necessary even though we soon discovered that major changes to the structure of the 305X4 specialty were planned in the near future. These changes involve, among other things, creation of some new "shredouts," deletion of some old shreds, and turning the work of some Air Force personnel over to civilian personnel (to parties as diverse in nature as the Federal Aviation Administration, and even the West German telephone company in the case of some overseas switching systems maintenance).

#### 2.1.5 Dynamic Cross-KPATH Analysis

Jobs are only one component of the U&T pattern. A concomitant effort was required to identify the training states (e.g., resident courses, Field Training Detachments or FTDs, Career Development Courses or CDCs, On-the-Job Training or OJT, etc.) that are needed to prepare people for their jobs, and determining the likelihood that training will be received as it is needed. The goal of another related effort was to determine the pattern of job flow; that is, the "transition probability" that incumbents in any given job would be assigned next to any other given job in the specialty.

One possible starting point for determining transition probabilities was so-called "dynamic cross-KPATHing." The procedure involves identifying people who participated in two (or, in theory, more) consecutive OS efforts. They may be identified by background information, such as social security number. Subsequent time 1-time 2 job comparisons are made according to the "KPATH" number, an index assigned by the

clustering procedure which indicates the point at which an individual entered a cluster. This index, obviously, lends its name to the procedure.

The next step involves determining which job each person was in during each survey period. The expected result would be a matrix of job-to-job transition probabilities that can be refined by additional efforts.

We performed a cross-KPATH analysis on three specialties (under an agreement with AFHRL staff, we did not plan to try all possible ways of building U&T patterns for each specialty); the AFSs selected for cross-KPATH analysis included 423X1, 305X4, and 328X4. The resulting matrices and additional issues were briefed at one of the TDS progress reviews.

The cross-KPATH effort did produce reasonable-looking matrices. However, a number of practical and theoretical problems limited the usefulness of, or at least the level of confidence one could have in the method. There are three particular problems, listed here in the order of severity.

First, the sample sizes may be small, and the estimates in some cells can be based on very few cases. This problem can be aggravated by the fact that some OS samples comprise a relatively small part of the specialty, as was the case with 811XX. That, and the relatively low retention level in that specialty after the first term, reduce the likelihood that cross-KPATH analysis will be based on a sample that is sufficiently large or representative.

Second, even with a large sample one cannot be certain that any particular cell entry represents single-step job-to-job transitions. As a general rule, several years intervene between OS efforts, although this can vary because OMC conducts studies mainly at the request of AFS managers. Data discussed below suggest that the average job incumbency period in many specialties is considerably shorter than the typical time between OS efforts. The point is that any given individual in a sample could represent one, two, or even three (and even more, in rare cases) job transitions. When used in a dynamic model, such information might be misleading in important ways.

Third, the jobs are not always easy to compare between two surveys. This results in part from the inherent subjectivity of the job-typing process, as mentioned earlier. It is possible that two analysts will identify somewhat different jobs when analyzing the same survey data. The overlap is likely to decrease when several years intervene between two surveys, and additional variability results from actual, substantial changes in the nature, training, mission, and equipment in the career field, quite apart from the analyst's perceptions and decisions. Finally, policy changes at OMC change from time to time. The level of specificity at which an analyst works (i.e., the degree of difference that must exist between groups for them to be called separate jobs) is in part a matter of current policy and practices.

The cross-KPATH analysis of AFS 328X4 can serve as a case in point. The two most recent OSRs for this career field appeared about 4 years apart, in 1978 and 1982. The 1978 report identified 10 jobs in the career

field, and the 1982 report identified 26. At one point, we consulted with a very experienced SME, a recently retired 328X4, who provided us with a mapping of the later job typing onto the earlier one. This might have resolved the problem if the mapping had been smooth (for example, if two or three 1982 jobs had mapped neatly onto each single 1978 job). Unfortunately, the mapping this SME produced was not so neat; for example, part of a 1982 job might map onto one 1978 job, another part might map onto another job, a third part might not map onto any 1978 jobs, etc. At the same time, a single 1978 job might have parts of several 1982 jobs mapped onto it. In short, there seemed no easy way to determine what the transition probabilities meant, at least not without determining how to proportion them among various alternatives. This in itself would have been a very subjective procedure.

The cross-KPATH analysis was not meant to produce final transition matrices, but to produce a helpful beginning point for further refinement. The same SME who translated jobs between OSRs was also working on the SME-defined U&T pattern effort described in Section 2.1.6 of this paper. He was offered the cross-KPATH matrix as an aid but chose not to use it. The point is that, in this case (i.e., this SME, this career field, and this pair of job type sets), the cross-KPATH product was not even considered a good starting point. Although we performed comparable analyses on two other specialties, we did not have another opportunity to map the results of one analysis onto another.

#### 2.1.6 SME Judgments

We explored a second method of devising U&T patterns. This involved simply working with a very knowledgeable SME or panel of SMEs, whose experience might allow them to draw a schematic (or do something equally suitable) of career field job flow and describe the training (as it is presently given, not the ideal) that prepares people for jobs. In other words, perhaps SMEs could supply all that was required at a suitable level of accuracy.

By agreement with AFHRL staff, we tested this method on each of the prototype TDS specialties except 811XX. There were several different tests for 328X4 and 305X4, both with consultants and with SMEs officially provided by AFHRL. Most of the official testing effort took place during trips to Sheppard and Tinker AFBs during the summer of 1986, and to Air Force Space Command Headquarters in Colorado Springs in the fall of 1986.

The results of these efforts were submitted to AFHRL as Preliminary U&T Models. In fairness, the fundamental job-flow patterns produced by the best SMEs were not bad (SMEs' abilities with this exercise varied considerably, although we always found a few who apparently did it well). We provided SMEs with information we thought might help (including, as has already been said, the cross-KPATH results). SMEs found much of the information available in an OSR helpful, especially that concerning such things as average grade and TAFMS of job type members, the most frequently performed tasks, additional narrative job descriptions, and the like. They were able to use this information in conjunction with their own knowledge (for example, about how assignments typically work in their specialty) to produce job flow diagrams that were reasonably accurate compared to those produced by our detailed OS data analysis (see Section 2.1.7).

However, some general findings serve to limit the usefulness of this method for determining U&T patterns. First, even the most experienced people had trouble with the job-training relationships that, along with job flows, are very important for accurate U&T patterns. Most simply said they did not know enough about, for example, the current or recent FTDs to determine the relationship between them and jobs with confidence. They certainly did not feel confident about estimating the percentage of job incumbents who, in connection with their job, receive any given FTD or resident school training state.

The second issue is a bit more subtle. Although the job flow patterns SMEs produced were fairly accurate, they were a bit oversimplified. For example, jobs were seen as available in too narrow a time window; SMEs tended to represent jobs too discretely as first-term or second-term or third-term. The effects of this on accuracy are probably more severe with some of the very large job groups than with some of the smaller ones, but SMEs did not seem generally very sensitive to the stated size of the job groups. They also failed to include some jobs in their models, perhaps simply overlooking them. They were sometimes critical because a job they believed should be represented was not. All this is understandable, but raises questions about the suitability of this method. It is possible that very detailed job typings will eventually be judged unsuitable for the TDS; simplicity in this regard already has proponents. Even so, some additional method would still be needed to determine job-training associations.

#### 2.1.7 Additional Surveying and OS Data Analyses

Early in this project, a consultant hired by AFHRL to review new TDS research and development plans, stated in his report that he did not see any way of getting accurate job-training association estimates without considerable (and at that time unplanned) additional surveying (Moore, 1984). It appears that he was probably right.

Although the information available from OS data is generally excellent, the OS for most specialties lists very few of the courses actually available to specialty members. Even for these courses, there is no information about when the course was taken; therefore, a particular course cannot be confidently associated with the member's current job. (These are not inherent or necessary problems; the OS could be devised so as to provide this and other information.) Cross-KPATH analysis never promised to provide job-training association data. On the other hand, it was disappointing to find most SMEs unwilling even to provide guesses about these associations.

Another possibility involved analysis of individual airmen's personnel records, but there were several practical problems. For example, although the recent training history would be reliable, it would still be difficult to associate training states to jobs because personnel records carry only very generic job titles. Mapping these onto OMC job type titles would involve yet another series of judgments by an analyst or SME. In addition, there were problems with access to personnel records.

##### 2.1.7.1 Job and Training History Surveys. We devised and field-tested a Job and Training History Survey (J&THS), to gather

information on dynamic job flow and job-training association information unavailable from other sources. The original agreement with AFHRL was that an additional surveying effort would cover only AFSs 328X4 and 811XX. By the fall of 1986, however, none of the other methods had produced U&T patterns that met expectations. The additional surveying was extended to AFSs 305X4 and 423X1, although project time was very limited by that time. Further details about the results of this effort were provided to AFHRL as Data and/or Analysis Summary - Current U&T Patterns, Task II.

What the J&TIS requested depends on the specialty. The survey for AFS 328X4 began with a copy of the standard background information page and Privacy Act Statement included in OS packages. The first section requested information on training history, asking specifically whether and when the respondent had taken various FID and resident courses, inter-service courses, Mobile Training Team courses, professional military education (PME) courses, etc. The section contained the specific names and numbers of as many courses as possible. This information was gathered mainly from new and old volumes of Air Force Regulation (AFR) 50-5, USAF Formal Training Schools, but other sources, including old and more recent OS forms and SME input, proved helpful. Generous space was provided for fill-ins, along with instructions asking for any other courses not included in the list.

The second section requested information about jobs. Each job type was described by a title, brief narrative, and short list of tasks typically performed. Participants were to read these descriptions and respond with dates if, in their opinion, they had ever occupied the job. They were instructed to pick one best-fitting job for each time period (except for filling in any periods of special assignments, of which examples were given), and leave no time gaps unaccounted for.

Additional sections requested information about the participant's major command (MAJCOM), aircraft worked on, and systems worked on, for each job selection made in the previous section.

A first form of this survey was pilot-tested with the help of AFS 328X4 personnel at Langley AFB in August 1985. It was revised as a result of their comments, and underwent additional revision as a result of suggestions by AFHRL staff members. It was administered in the field in the fall of 1986.

The survey for AFS 811XX differed somewhat from that for 328X4. The original form was very similar, but pilot-testing at Scott AFB in January 1986 showed that considerable revision was needed. One revision was to include Educational Subject Block Indices (ESBIs) as a primary training mode for this AFS. The main revision, however, resulted from the resistance of 811XX personnel at Scott to picking a single job type for any given time period. They insisted that their jobs were broad, including many short-term assignments to special functions, and daily jobs which cut across many of the job types identified in the CCT. For this reason, on the final J&TIS respondents were asked to rank a long list of 811XX functional areas according to the amount of time spent by each in their present assignment, previous assignment, etc., instead of being asked to pick jobs. We were hopeful that OS job descriptions could then

be related to functional area ranking patterns (but met with little success in doing so). This survey was also in the field during the fall of 1986.

The J&IHS for AFSS 305X4 was similar to the 328X4 survey with regard to asking respondents to select OS jobs for each assignment period. The one for 423X1 was like that for 811XX in this respect, requesting rankings of functional areas worked in each assignment. This approach seemed best in light of the unconventional homogeneity of 423X1 indicated in the OSR. We thought it might be possible to use data on 423X1 functional areas, if necessary, for additional breakdown of the specialty and for the job-training analysis. We were unable to pilot-test these surveys to determine if this was the best way to gather job information in these specialties, due to the short period of time remaining in the project. Finally, these surveys were somewhat abridged, relative to those for 328X4 and 811XX. This was because they were intended as a quick-response effort for the main purpose of gathering some then-still-available training data.

We were unable to analyze and use the full complement of information which resulted from this surveying effort, partly because of the unanticipated additional surveying and partly because surveys arrived in the field much later than originally anticipated. It is possible that the additional information available from these surveys will be of use in the future on this or another project. As it is, data from the J&IHS were used in the prototype TDS mainly to estimate the likelihood that a job incumbent will receive training in a particular training state. In some cases, additional information from the survey was used to estimate the point in an average career when certain training is given. For the 811XX pattern, information from the survey was also used to estimate CDC course completion points, PME course sequence and timing, ESBIs completed, and the duration of an average first assignment, second assignment, etc.

2.1.7.2 Additional OS Data Analyses. In the end, the OS remains the best source of much information about the current U&T pattern. The data are often based on an effort which affords everyone in the career field the opportunity to respond or samples sizeable numbers of large AFSSs. It is also easy to use; the CODAP program called PRTVAR easily extracts individuals' OS data from the Case Data File, and convenient data-analysis software systems such as the Statistical Package for the Social Sciences (SPSS) may be used for manipulating and analyzing the information. The biggest drawbacks (for present purposes) include the lack of dynamic job-flow information, the relative incompleteness of the training information in many cases, and the unavailability of dynamic retention rate estimates. In short, we used OS data to substitute for some of the information we had hoped to get from other sources (e.g., the Occupational Research Data Base, or ORDB).

In any event, OS data served many purposes in the prototype FUS model. Much of the transition matrix for the current pattern for each specialty was calculated from OS data, including estimates about job-to-job flows, reenlistment/leave rates, rates of cross-training into the specialty and other modes of entering the specialty. OS data even supplemented the J&IHS data on job-training flows when there were inadequate returns for some smaller job types.

### 2.1.8 Job-TIM Associations

OS data were also used to determine Job-TIM associations. TDS job descriptions must be written in terms of the TTMs produced by the TCS, rather than in terms of the original task list usually used for such descriptions.

We used the CODAP system to generate these descriptions. The process begins with creation of a Module Title File from a standard Task Title File, followed by creation of a Module Factor File. The Module Factor File is used as input to the CODAP program MODSET; the output from MODSET is printed using the PRIMOD program. Although this process allows one to select or create a number of indices to represent a Job-TIM association, we selected four for use in the prototype FUS. All are straightforward aggregations over the tasks in a TIM of some indices familiar to anyone experienced with job-task association. The indices appear adequate to describe the association for a number of purposes, and include the following:

1. The sum across people and tasks of the percent time spent performing the tasks in a TIM.
2. A running cumulation of this sum percent time spent index.
3. The average percent time spent per task on the TIM (i.e., the cumulation / # people).
4. The average percent members performing across tasks of the TIM.

Based on a need of the Training Systems Division of AFHRL, a facility to compute the cumulative sum of percent time spent was added to CODAP.

### 2.1.9 SLAM and New Simulation Software

Another concern in developing dynamic U&T patterns involved determining what kind of model should be used for projecting future requirements and consequences for current and alternative U&T patterns. Originally, we thought it likely that a simple single-step Markov model might be the best sort to use. Eventually, however, we became interested in using techniques of dynamic simulation modeling.

At first, we explored the possibility of using the well-known simulation language SLAM (Pritsker, 1986). The results for initial, simple, imaginary U&T patterns were encouraging. The language was relatively easy to use and seemed adequate for the job's requirements.

Unfortunately, as actual U&T data were accumulated, SLAM seemed less and less appropriate for this particular application. SLAM is actually intended to simulate the experiences of discrete entities moving through a system one at a time, with little or no iteration through the same or very similar experiences. FUS job flows, however, are characterized by large numbers of entities repeating the same or similar experiences many times. For present purposes, several features inherent in SLAM became increasingly cumbersome limitations as the patterns we tried to model became more realistic and complex.

We adopted the solution of writing new simulation software. It is

actually part of the IOS, but the new software was written to be FUS-specific. It serves the functions required by the FUS with no additional features or limitations.

## 2.2 The Alternative Utilization and Training Pattern Component

### 2.2.1 Assembling Alternative Patterns

Alternative U&T patterns could involve changes, relative to the current pattern, in jobs (e.g., jobs could be comprised of different sets of TIMs, or could be performed by more or fewer specialty members), changes in the number or types of training states, or changes in the transition probabilities between jobs or training.

We began work on assembling alternative patterns in concert with the effort to get SMEs to define the current pattern (see Section 2.1.6). Many of the SMEs who helped in that effort were also asked about possible changes in the structure of the career field. Each time we spoke with people in the field about such issues, we also solicited information about career field problems and possible solutions. Unfortunately, it seemed difficult for many of the people we were working with to understand the sort of suggested alternatives we were after, even though they had just been considering the current pattern. In addition, suggested alternative patterns were more difficult to extract from 811XX and 423X1 incumbents than from the 328X4 and 305X4 members, apparently because many in these career fields were very satisfied with the overall current configuration. It is often frustration with identifiable, fixable problems that spawns a number of alternative suggestions.

Most of the alternatives represented in the prototype system were suggested by various sources during visits to operational bases, to the Office of Security Police at Kirtland AFB, and through a special session during the 811XX U&T Workshop at Lackland AFB in May 1986. We reduced ideas to descriptive narrative and an accompanying flow diagram, and described the current U&T pattern in the same way.

### 2.2.2 Products of the Alternative U&T Pattern Component

One product of this component is the set of alternatives itself. In many cases, the alternatives represent interesting restructurings of work and training in a career field.

Another product is the output of a simulation run, much like that provided for each current U&T pattern but now performed for each alternative in each specialty. It would be desirable to have these data available during the management preference surveying process; this was not possible for the prototype effort. The projections of consequences might become an important factor in some managers' preferences. Simulation runs can show that some alternatives are simply not viable without considerable additional changes. For example, requiring that certain jobs not be performed by first-term individuals can leave them badly undermanned unless current retention rates can be improved dramatically. Such information could be important to anyone who considers this pattern a potential solution to another existing problem.

## 2.3 The Management Preferences Component

### 2.3.1 Survey Administration

The U&T pattern narratives and diagrams were assembled into booklets, one for each specialty, and administered face-to-face (with a handful of exceptions) to functional, personnel, training, and other kinds of managers and senior personnel in each specialty during July 1987. The analysis and results of this surveying effort were provided to AFHRL as a Data and/or Analysis Summary. Briefly, the effort succeeded in achieving its objectives. Moreover, interrater agreement ranged from acceptable to very high for each specialty. Still, several suggestions were offered to improve the process. These included the following:

1. Perform a pilot study for each survey. This is mainly intended to improve the final survey. Several respondents found it easy to suggest new patterns by altering or reacting to some others already presented to them.
2. Be more explicit in requesting comments about the survey or eliciting additional alternative patterns.
3. Administer this survey in a face-to face interview session whenever possible.
4. Include a wide variety of managers in the sample. During this prototyping effort, manpower, personnel, and training managers were consistently underrepresented.
5. Performing additional exploratory statistical analyses might be valuable, for example, to identify underlying components important to acceptance of a pattern.

### 2.3.2 Products of the Management Preferences Component

The main product of this component is Manager Preferences. These are expressed in the form of ratings on a 1-to-9 scale (1 showing low preference, 9 showing high preference) in the prototype. The preferences may be aggregated at different levels, as necessary. The prototype TDS presents, for each alternative, overall average ratings for the entire sample of managers, and also numbers of respondents and average preferences for each "type" of respondent.

## 2.4 Evaluation of the FUS

We also evaluated the FUS developed for the prototype. This involved another survey effort, which was carried out simultaneously with the Management Preferences Survey; the results were also reported in the Data and/or Analysis Summary.

The Evaluation Survey consisted of five questions and opportunities for additional comments. Each question was answered by checking either "Yes," "No," or "Uncertain." Question 1 asked about the usefulness of the method by which the survey presented the current U&T pattern description; Question 2 asked if the description was accurate per se; Question 3 asked if the description accounted for personnel flow throughout the entire

career; Question 4 asked if the alternative patterns were understandable; and Question 5 asked if there was a better way (than that instrument) to gather preference data. People answering "Yes" to Question 5 were specifically asked for their ideas in that regard, but respondents were encouraged to provide additional comments on any or all of their answers. As with preferences data, these responses were compiled and presented in two tables: one for overall tallies, and one which tabled responses by type of manager.

Evaluation results were generally very favorable. Most found U&T patterns and alternatives very useful and understandable. Unfortunately, there were very few comments to explain any negative reactions there were. The main recommendation offered about this survey was that respondents be asked more directly and specifically to explain what they dislike about the effort or the survey itself.

### 3.0 CONCLUSIONS AND RECOMMENDATIONS

Overall, the FUS-building effort has been successful. The completed model appears coherent, internally consistent, and ready for extended testing. Sensitivity analyses have already been planned which should uncover and correct any hidden flaws the model or implemented system may have.

The prototype system will be configured to produce the reports and other information which TDS staff members from AFHRL, McDonnell Douglas, and CONSAD Research Corporation have agreed are likely to be most useful in meeting FUS requirements. Many of these were reviewed by the TDS Advisory Panel at the January 1987 progress review. It is likely that additional useful products can be assembled from existing data, if user communities require further reports. Additional data can be collected as warranted.

On the other hand, one can wish for something else, perhaps something better. In collecting some of the data and developing some of the methods we have tried various alternatives and ultimately used the best that were at hand. But there are other methods that were not tried, for various reasons. Some methods were considered high risk; they would likely produce better data if they worked, but would take a lot of time and money without particularly high assurance that they would work. In other cases, pressing demands did not allow the luxury of additional effort when a workable method was at hand. In still other cases, we had no control over events or access to sources that might have yielded better data.

The purpose of this section is to provide observations on the quality of the present model or data, suggest specific improvements when possible, and discuss pertinent issues when specific suggestions can or should not be made. In any event, many possible changes to the FUS process would be more a matter of policy than of need.

#### 3.1 The Current U&T Pattern Component

The greatest number of problems and suggestions concern this component. This is not surprising; the current U&T pattern is the key to the entire subsystem. Also, much of the RCS requires accurate input from the FUS if it is to work properly.

##### 3.1.1. Job-Typing

The present method of job-typing basically consists of reviewing and revising the OSR job types as necessary. This approach was judged tentatively acceptable in all four prototype TDS specialties, but there are some shortcomings. Whether improvements on the present methods are required depends on how well the present methods serve, and whether there are any future extensions to the present FUS.

3.1.1.1 Non-Hierarchical Clustering. Not all people are assigned to specific jobs under the present hierarchical clustering methodology. These people were placed in a "no job type" category for the prototype effort. This approach may present no particular problem, and could be used for some time to come. The "no type" category can be described in terms of TTMs, linked to training requirements, ascribed a retention rate, etc. like any actual job type. The data fed to the RCS as a result are perfectly good. But there are questions about how accurately hierarchical clustering produces representative job types, and the typical failure of the procedure to assign up to 20% of an AFS's members is symptomatic of possible troubles. The matter deserves attention if the FUS is to be interpreted as a highly accurate portrayal of the current system.

Research and testing of a new non-hierarchical approach is underway at AFHRL. Indeed, TDS requirements have provided some of the impetus for these investigations and perhaps hastened their eventual success. The potential advantage comes from the fact that these non-hierarchical clusters can form and reform more easily. With hierarchical methods, an entity is captured for good once it is pulled into a group. The formation, at a later stage, of a possibly more similar group has no effect on that entity. The entity, in turn, alters the overall character of the group which captures it, affecting which other entities are later captured by that group. This situation is relaxed under non-hierarchical clustering. As a result, one recent study (Mitchell & Phalen, 1985) found that the number of unclustered people dropped dramatically, relative to the hierarchical approach.

The impact of this issue on the FUS is not clear, but several improvements might result from using a different clustering scheme. For example, the issue of first-term versus career job types could be re-investigated. The problem involved in splitting the sample was that the effects were not always easily interpretable. In some instances, members of a whole-sample job type wound up a considerable distance from one another on, say, the first-term-only diagram. They might not come together again until joining in a big group that had many other members and intra-group similarity indices too low to indicate that the group was a job type according to the usual guidelines. What is one to make of this, especially when further examination reveals that the subgroups are still not very different in job descriptions? They might overlap greatly in tasks performed, but spend very different amounts of time on subsets of those tasks. Moreover, in some instances one could also identify very comparable patterns between career and first-term diagrams, with an almost complete mapping of groups and subgroups.

One possibility is that hierarchical clustering may overelaborate the heterogeneity of some career fields for the purposes of the TDS. This was very possibly the case for the FUS model of AFS 328X4, in the opinion of the analyst who performed these studies. Even some of the job types eventually used were not terribly different from one another, except in the amounts of time spent performing the same tasks. One could make a good case that such jobs are not different in terms of training required. The complication is that because "jobs" are comprised of task clusters, different jobs in the current pattern may not require different training in some cases; but in other cases, working the same job on different

aircraft might. Also, although unclustered people are considered by the TDS, in practice their representation is limited since they are obscured by membership in a very large ("no job type") group. When cutoffs are established that limit the number of TIMs used to describe a job, the final result is that many people may not be represented at all.

3.1.1.2 Additional Classification Approaches. There are other possibilities for changing, and possibly improving (for TDS purposes), the job types. A method could be devised whereby individuals are clustered according to the degree to which they perform entire TIMs, rather than tasks. In a case such as 423X1, in which there was a single job type that accounted for over 80% of the specialty, it would be worthwhile to attempt a discriminant analysis to classify people according to additional background variables. This might allow separation of the large job into reasonable-sized jobs according to the aircraft worked on, for example. Such jobs might not meet OMC's needs, but the usefulness of such job types for purposes of the TDS remains an open question.

3.1.1.3 SME Review. In any case, the ideal situation for final job selections in an AFS would allow for review and comment by several SMEs who have been trained to the point where they understand and endorse the FUS effort, at least to some degree. The prototype job types were reviewed by SMEs, but they were seldom knowledgeable about the TDS or the job-typing process.

3.1.1.4 Changes in Specialties. AFS 305X4, one of the specialties considered in the prototype TDS effort, has been preparing for substantial changes over the last couple of years. Several old shreds were about to be replaced by new ones, with corresponding major changes in equipment and training courses. This presented certain problems throughout the current effort, and one result is that the present TDS 305X4 configuration represents the old form of the specialty. The issue of how to deal with similar situations in the future and the related issue of whether it is desirable to begin a TDS study on a specialty that may soon undergo substantial change both deserve further research. It may be that the TDS can be particularly helpful if additional planning is done and the study is conducted with additional or somewhat different goals in mind.

On the other hand, we have been informed by personnel at Offutt AFB of planned changes to AFS 328X4, at least in Strategic Air Command (SAC). The proposed changes generally involve combining duties with those of other specialties. The TDS can be useful in this situation, but its usefulness may be limited to examining the impact upon the 328X4 part of the new, combined specialty. This is because (with a few exceptions) the system is presently designed to consider changes only in a single specialty in isolation. However, the TDS could be expanded to consider multiple AFSs simultaneously. Any such extensions should proceed with a view toward modeling the sort of changes now planned for AFS 328X4.

3.1.1.5 Coordinating OS-TDS Efforts. Many advantages could result from close cooperation between the TDS process and the OS process. Some of the job-typing problems discussed above might be resolved if more or less specific task lists were used in the OS (for a discussion of this issue, see Mitchell et al., 1986). This is not to suggest that TDS

considerations should drive the OS process, but ideally a high level of mutual decision-making would exist between the two efforts. Also, OS and TDS studies should probably be begun simultaneously to maximize this coordination, and a program should be worked out for coordinating and intertwining OS-TDS data gathering and analysis steps. It might also be beneficial to assign a single analyst to do the entire sequence of TDS work on any given specialty. This would allow analysts to develop proficiency in all aspects of the TDS and to work closely with the counterpart analyst working on the OS effort, and it would minimize coordination problems with TDS users, OMC, and other entities. It is possible that the RCS might require a second analyst with considerable expertise in economics, but the minimum feasible number should probably be used in any event.

### 3.1.2 U&T Flow Patterns

It is also possible that the methods described in this paper will be judged suitable for the operational TDS. As with job types, any number of alternative methods are possible. Policy decisions and considerable TDS testing will establish whether these are or are not needed.

3.1.2.1 Simplifying Assumptions in the Prototype. The transition matrix for each specialty implicitly reflects a number of simplifying assumptions. One example is the lack of job-to-job transitions. Instead, an aggregation node was used in each matrix and corresponding simulation. Job-changers are simply aggregated and reassigned to new jobs randomly according to TAFMS cohort. Actually, this approach closely models the true assignments process as it has been described to us repeatedly by SMEs. However, if job-to-job transitions are desired, they can probably be calculated.

The J&TMS effort provided some vital information that could not be obtained elsewhere, but for various reasons (e.g., small or zero survey returns for many jobs, lack of time for analysis once the surveys finally began to return from the field) was unable to support some possible FUS features such as job-to-job transitions.

Close cooperation between the OS and TDS processes would serve to alleviate many of these problems. Also, the J&TMS effort should begin a TDS study, rather than coming toward the end of one. With sufficient cooperation, virtually the entire OS sample would also have the opportunity of supplying information required for the TDS. In addition, the larger sample would probably allow a certain degree of "cleaning" of the data. For example, in the prototyping effort the J&TMS sample was so small that we needed to use all the job histories available. In a few cases, this meant that we were using subjective job histories supplied by people who had failed to pick their present OS job correctly, or who indicated that they changed jobs every couple of months on the average. In some sense, these people have shown either that their judgment or adherence to survey instructions is questionable, or that they really are atypical for some unknown reason. With a much larger sample, we might be able to afford the luxury of establishing criteria that determine which responses should be kept. Perhaps only those who correctly identify their present job (according to the OSR) would be included, or only those who both pick the correct job and do not indicate an average of more than one job transition per year. Just what are or are not good criteria deserves

investigation; without sound justification there is danger of keeping only those responses that fit one's expectations.

3.1.2.2 SME Input. Another matter of potential importance to the J&THS involves early input from knowledgeable SMEs. The prototype TDS, for example, contains no information about MAJCOM-specific training courses. We were simply unable to obtain sufficient information about such courses. Even now their importance for the TDS is unresolved; it may be that they are best omitted. As another example, the prototype does not include information regarding "generic" FTDs, which receive students from any number of AFSs. Examples include FTDs that teach about digital technology, high-reliability soldering, serving as an OJT supervisor, and the like. Our present impression is that they should be included because they provide a lot of apparently important training. It was too late to determine which TMs are taught in such courses by the time surveys were returned and we realized their importance.

In some ways, this situation reflects another important instance of oversimplification. The prototype FUS implicitly assumes that any training not provided in one of the training states included in the model is provided by OJT. Thus, it is important to determine the optimum number and type of courses to include, so as not to badly overestimate the OJT burden. The approach used in the prototype tends toward making reality fit a model. Probably the best way to resolve this problem is to interview a wide variety of working AFS members as part of the J&THS assembly process. Incumbents are probably the best judges of where they receive the training important to their current work and future career aspirations, and should be closely involved with the entire process of planning the survey effort and constructing the survey itself.

3.1.2.3 Streamline Survey Processes. The mechanics of the Job and Training History Surveys could use additional investigation and pilot-testing. Ideally, initial construction would assemble the job/training state lists. This could be followed by pilot-testing to see, for example, if a decision-tree structuring might aid respondents in picking jobs for each time period. Also, we might obtain better results if people were asked to relate training courses to particular jobs directly in their own histories. The present format required that respondents list jobs and training separately, and the two were linked afterward by assuming that training given in any period was pertinent to the job occupied in that period. This may or may not be valid. In any event, the case has already been made for asking the people what they think was their actual, pertinent training for each job.

3.1.2.4 Future Extensions. An FUS model could potentially become very exact and complex, given sufficient information from a large sample. To give a single example, one might be able to model job flow among various commands and bases. A truly dynamic model might show fluctuations in flow across bases or other entities according to the simulation start time selected. Or, the model might devise and use abstractions such as "representative bases" to examine differences. The main purpose of such a complex model would be to help the RCS establish the most accurate cost/resource requirements estimates possible.

Another important extension of the FUS would involve further use and

coordination of different sources of data. For example, the prototyping effort involved only limited use of the ORDB, and left unresolved many issues concerning coordination of that data base with additional information from the OS TDS-specific surveying efforts, and other personnel and training data bases.

### 3.2 The Alternative U&T Pattern Component

Little needs to be said about this component. The effort went smoothly and the information gathered appears satisfactory, unless it becomes desirable in the future to alter the nature of the component considerably.

Moreover, some pertinent comments have been made earlier in this paper. We have previously discussed the observation that SMEs appear most able to offer alternative patterns if they have examples of alternative U&Ts in front of them. These alternatives need not be sophisticated; crude examples which, say, simply eliminate a training setting might serve the purpose. This and a few other straightforward changes to the ways in which alternate patterns are designed could be very helpful.

Another suggestion can be offered. It might be advisable to allow J&THS respondents to suggest alternatives. The possibility of asking them about very job-specific training has been discussed. Additional questions could ask about additional desirable training for each job that was not received, or about unnecessary training that was received. Respondents could also express opinions on combining or dividing jobs. Analysis of the resulting data could suggest alternatives that attempt to resolve problems perceived by lower-echelon personnel in the field.

### 3.3 The Management Preferences Component

Again, some potentially important improvements to this component have already been discussed. On the other hand, implementing some of these suggestions in conjunction with each other could enhance the value of this component considerably.

#### 3.3.1 Simulation Runs

Simply having the results of current and alternative U&T pattern simulation runs, as well as various RCS and IOS products, available for SME inspection would allow them to make much more informed preference decisions.

#### 3.3.2 Statistical Modeling

We have already mentioned the possibility of using statistical modeling techniques (for example, multidimensional scaling) to explore the components of managers' preferences.

#### 3.3.3 SME Comments

The report on the prototype effort in this subsystem contains little information about the comments made by respondents, primarily because few comments were offered. It would probably be best to ask directly what people like or dislike about any given pattern, more or less forcing an answer. At present, a user will know the results of the

preference-gathering effort; however, experienced builders of decision support systems realize that this sort of information is often disregarded if presented in isolation. The user should be provided an adequate frame of reference to increase acceptability.

In short, we might determine which patterns are preferred, find out why they are preferred, and find out what problems their implementation could bring. If the process could be implemented successfully, iterative revisions and preference surveyings could create alternative patterns that various managers would like, that would be practical, and that would be cheaper to maintain. This information could enhance the FUS contribution to the Air Force and Air Force training.

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## ACRONYMS AND ABBREVIATIONS

AF	Air Force
AFHRL	Air Force Human Resources Laboratory
AFMPC	Air Force Military Personnel Center
AFR	Air Force Regulation
ATC	Air Training Command
BMT	Basic Military Training
CDC	Career Development Course
CODAP	Comprehensive Occupational Data Analysis Programs
ESBI	Educational Subject Block Index
FUS	Field Utilization Subsystem
FTD	Field Training Detachment
IOS	Integration and Optimization Subsystem
J&THS	Job and Training History Survey
MAJCOM	Major Command
MTT	Mobile Training Team
OJT	On-the-Job Training
OMC	Occupational Measurement Center
ORDB	Occupational Research Data Base
OS	Occupational Survey
OSR	Occupational Survey Report
PME	Professional Military Education
RCS	Resource/Cost Subsystem
SME	Subject-Matter Expert
SPSS	Statistical Package for the Social Sciences
STS	Specialty Training Standard
TCS	Task Characteristics Subsystem
TDS	Training Decisions System
TPT	Training Planning Team
TTM	Task Training Module
U&T	Utilization and Training

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